NEWS RELEASE

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Commencement Address
by B68
James E. Webb, Administrator
National Aeronautics and Space Administration

WILKES COLLEGE
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OUR NEW SCIENCE AND TECHNOLOGY -- SPACE FOR GROWTH!

It is a privilege to be here tonight to share with you an event which marks not so much the conclusion of one phase of your experience as it does the beginning of another.

The pleasure of ushering a group of alert and enthusiastic graduates into the world of opportunity which lies ahead is one which has come to many thousands of speakers since the process of formal education was first devised. Not all of my predecessors, however, have had the good fortune to perform this mission during an era which offered so much promise. Some of them, indeed, in more dismal periods of our national history, must have struggled mightily to find encouraging and stimulating thoughts with which to launch their listeners on new careers, or a continued search for knowledge.

You are emerging from your undergraduate experience in a time of challenge and opportunity which at least equals, if not exceeds, any other in man's laborious progress from primitive circumstances to the complex and highly developed society that we know today.

We live in a period of scientific progress which is providing us with new knowledge, new processes and new materials at an unprecedented rate. We are witnessing a leaping technology with which men are hard put to keep pace. Ideas which, a few years ago, were largely found in pulp paper fiction today form the core of scientific and technical publications. Predictions which seemed visionary and unrealistic only yesterday, are being fulfilled today at a pace which is outstripping the early hopes of the most optimistic authorities.

I recall a commencement address given at a western college in 1957, only five years ago -- five years yesterday, to be exact -- in which the speaker quoted a timetable for space exploration which had been drafted by a leader in the aeronautics industry.

The business leader who was quoted was a man well-versed in the subject and deeply concerned with our future efforts in space. He predicted that within a dozen years -- or about 1970 -- a satellite would circle the earth and the moon.

About 1990, he went on, space science and technology would have advanced to the point of launching a space ship carrying human beings which would circle the earth for an extended period as a satellite, and then return safely.

And then, reaching far into the future, he suggested that shortly after the year 2000, men might take passage on a space ship which would land on the moon and return to the earth.

These seemed dramatic and far-reaching goals at the time, but we all know how conservative they have become in the intervening five years. In fact, both the originator of the predictions, and the commencement speaker who quoted them, are acutely aware today how conservative they were.

The man who created this timetable was James S. McDonnell, president of the firm which produced the Mercury spacecraft in which John Glenn and Scott Carpenter orbited the earth. The astronauts anticipated his schedule by almost 30 years.

The commencement speaker who quoted him was James E. Webb.

I tell this story on myself, because it illustrates so vividly the pace at which science and technology are moving in this 20th Century. Since becoming Administrator of the national civilian space effort, I have seen the fulfillment of the first two of these predictions, and find myself participating in an enterprise which will endeavor to accomplish the third -- that of lunar landing and return -- within this decade. If we achieve this goal recommended by President Kennedy, and established by the Congress, it again will be some 30 years in advance of the date which seemed probable as recently as five years ago.

The geometric progression of accomplishment in scientific research and technology will be the dominant feature of your lives. Unlike most of your forebears, you will never have the opportunity to become fully adjusted to the world as you know it before you have thrust upon you, or before you help to discover and develop, new ideas, new methods, and new products which will change the way you live.

We live in a world of change, and more than any other generation, have learned to accept it as a fact of life. This is in sharp contrast with the situation which prevailed during most of human experience.

About two thousands years before the birth of Christ, man had already invented the wheel, something unknown in nature, and the sled became the wagon. In time, hand carts became horse-drawn chariots. But after that development which greatly affected civilization, little technological progress was made until the time of George Washington.

I read recently an interesting comparison of the situation of King Solomon with that of George Washington. Both men wore homespun clothing, both illuminated their houses with oil lamps, both heated with wood, both traveled in horse-drawn vehicles.

The period of human development which lay between King Solomon and George Washington covered almost 3,000 years. That between Washington and ourselves is hardly more than 150 years, but what a contrast in human progress.

Between the time of Washington and the beginning of our own century, a similar situation prevailed. When Charles Newbold, of Philadelphia, invented the cast iron plow in 1797, and decided to devote his life and fortune to it, he died believing that his life had been wasted. Except for Thomas Jefferson, and a few of his wealthy friends, farmers would have none of the iron plow, convinced that the iron poisoned the ground, or encouraged weeds to grow.

In 1825, when the British Parliament was debating the construction of a railroad between Liverpool and Manchester, many of the Members were convinced that no one would dare to ride such a fiendish device. It was asserted that travelers would sooner let themselves be "blown away atop a gunpowder rocket than trust themselves to such a machine."

One wonders what those statesmen would say of Shepard, Grissom, Carpenter, or Glenn.

Within our own century, science and technology began a rapid acceleration, but even this was most gradual until very recent years. For example, despite his own advanced thought in other fields, Edison almost buried the airplane, just after Kitty Hawk. He told reporters that the contraption could never have any practical value and would, at best, be nothing more than the toy of wealthy sportsmen.

It was almost 50 years from the Wright Brothers' flight until we learned to build an airplane that could fly faster than sound, at 700 miles per hour. But little more than a decade was required to go from that 700 miles an hour to 4,000 miles an hour in the X-15, and by 1959 we were reaching out beyond the earth's atmosphere with spacecraft which could travel up to 25,000 miles an hour -- fast enough to overcome the earth's gravity and speed out into the solar system, never to return.

In 1939, Niels Bohr listed fifteen important reasons for his conviction that the atomic fission process would not have any practical application. Yet, in the same year, Albert Einstein wrote his now historic letter to President Roosevelt which read:

"Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future.

"This new phenomenon could also lead to the construction of bombs."

Even in the field of rocketry, despite the fact that the principle dates back more than 1,500 years, pioneers in the first half of our century encountered great skepticism and resistance. Dr. Robert Goddard, the father of the modern rocket, found little enthusiasm for his assertion that "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow." Rockets became the symbol to many of impractical ideas and grandiose schemes, and Goddard and other rocket pioneers inherited the mantle of ridicule worn by the Wrights, Langley, and the other airplane pioneers.

If you find the recollection of these facts startling, it is because most of us rarely stop to think how new everything which we call technology actually is.

Heinz Gartmann has suggested that this is because "in time as well as space there is a psychological effect which we may call foreshortening due to perspective. Events of the past millennia lying hundreds of years apart appear to us virtually contemporaneous."

Thus, to someone who is alive 4,000 years from now, in 5962, Aristotle, Leonardo da Vinci and Einstein will probably appear as belonging to the same period of human development.

But what does all of this mean to you? How will it affect your lives and your careers?

Let me state it again. Change, and the rate of change, will be the dominant feature of your existence.

Change means different things to different people. To some it means an uncomfortable uprooting of a settled existence. To others it may mean disillusionment and despair. To still others -- and this is the group in which you can place yourselves -- it means progress and opportunity.

This is a contrast, I know, which I scarcely need make in 1962 for an audience in this part of our country. Some of your families and friends have, I know, been victims of change. But just as the sons of wagonmakers found new careers in the manufacture of automobiles, so will the sons and daughters of Pennsylvania coal miners find opportunities in developments stemming from science and technology and the very large research and development effort associated with it.

One of the problems of our highly developed science and technology, and the automation which it is bringing to business and industry, is that of finding an outlet for the human energy which new machines and power sources have displaced.

When you consider that the energy embodied in one gram of matter corresponds to the normal annual output of fourteen thousand human beings; when you view the effects of automation on our requirements for human energy, it is evident that man's own energy must be put to use in new ways for the benefit of mankind.

The solution to this problem lies not in reducing the number of hours in which we make a constructive contribution to human progress, and diverting human energy to non-productive purposes. It lies rather in finding new areas in which man can expend his energy for his own benefit, and that of his fellow human beings.

This is among the reasons why our present and future efforts in space are so important to all of us. Just as the United States government's first venture into scientific exploration -- the Lewis and Clark expedition -- led to the opening of the West and created a new frontier for the young people of that day, so are our government's activities in science and technology today opening a new frontier for our college graduates of this and the coming years.

The extent to which you and your contemporaries will benefit from this new science and technology, the extent to which you will participate in reaping the harvest of space research and exploration, will depend largely upon the extent to which you prepare yourselves to take advantage of it.

You have had the opportunity, during your elementary and secondary education, and during your four years of undergraduate work at Wilkes College, to lay the groundwork for a career geared to the complex age in which you live. You have the opportunity, if you choose, to continue that education and acquire the more detailed and refined knowledge which graduate education can provide, or to venture immediately into fields of business and industrial activity which will provide you with the kind of experience which will enable you to cope with a fast-paced modern world.

In either event, the space age offers opportunity for you. You have space in which to grow.

I often feel that the more glamorous aspects of the space program -- the dramatic features of manned space flight -- have a tendency to overshadow the basic and fundamental purposes of the space effort in which we are engaged. Just as the moon has influenced the course of young lovers for centuries, so has the excitement of lunar exploration blinded many to the more immediate and far-reaching benefits and influences which the conquest of space will provide.

Journeys into space and voyages to the moon are and will be thrilling human experiences. But we cannot all be astronauts.

A decade ago, when our present astronauts were test-flying the jet aircraft which were the parents or the grandparents of the jet passenger planes of today, few of us expected ever to share their experience. Yet millions have benefited from their activities, and contributed to the growth of the aeronautics industry as passengers, or in the design, construction, supply and maintenance of planes, or in the countless service industries which have developed because of them.

Similarly, it is unlikely that many persons alive today will have the opportunity to serve as astronauts, but it is certain that the knowledge gained in space research and technology will affect us all.

Today, a premium has been placed on knowledge, for man's survival depends upon how rapidly he accumulates knowledge concerning both his environment and himself, and how effectively he learns to use that knowledge. He no longer must fear change, for it is within his ability to influence the changes which are to come, and to determine whether the resources at his disposal will be used in the common victory of mankind, or abused in its ignominious surrender.

The missions of Shepard, Grissom, Glenn, and Carpenter were the product of years of research and development involving literally thousands of scientists and engineers with the training, the knowledge and the imagination to venture successfully into the unknown. Yet, complex as these missions were, and demanding on the talents of those responsible for the effort, Project Mercury and its spacecraft will, within this decade -- perhaps within a year -- become outmoded.

It will be followed, only next year, by Project Gemini, the next step in preparation for man's ventures further into space. The scientific and engineering brains of the Nation are already hard at work on this effort which will launch two objects into orbit, and then join them together as they circle the earth at 17,500 miles an hour. Among the things we will gain from this experience are a further knowledge of weightlessness and other problems of the space environment.

Subsequently, in Project Apollo, larger space vehicles whose height exceeds that of the Nation's Capitol will escape from earth orbit and rocket to the moon. First they will travel in manned circumlunar flight, and finally for lunar landing and return.

Meanwhile, scores of scientific satellites will be launched to orbit the earth, and numerous rockets will be dispatched to the far reaches of deep space. While answering questions which have perplexed men for centuries, they will accumulate information which will contribute significantly to our lives today.

Although still in its infancy, space exploration has already produced much new knowledge and many useful benefits for mankind.

The vehicles in our scientific satellite program perform scores of experiments aimed at adding to our basic knowledge of the earth, the moon, the sun, the entire universe. Their investigations may be defined in four major categories:

First, they investigate the region in the vicinity of the space vehicle.

Second, they study the earth by viewing it from above.

Third, they examine the radiation from the sun, planets, and stars before it passes through the earth's atmosphere.

Finally, they yield information which will facilitate the manned exploration of the moon and the planets.

The final category lies largely in the future, but much useful information has already been obtained from the first three. Because most of this knowledge is in the field of basic science, and highly technical, it has not received the popular attention accorded to manned space flight. Yet, this basic knowledge is the raw material on which a developing technology feeds, and consequently is of vital importance to all of us.

What have we learned from our scientific investigations in space?

In the first category which I have outlined, that of investigating the region traveled by space vehicles, we have the discovery, in 1958, of the Van Allen radiation belts, a region of charged particles which surrounds the earth.

Significant discoveries in this first category have also been made in the measurement of magnetic fields, atmospheric density, micrometeorites, and the properties of the ionosphere. In the latter case, sounding rockets made it possible for the first time to measure directly the properties of the ionosphere, a region surrounding the earth that contains a high concentration of free electrons that reflects radio waves. Later satellite observations have made a continuing contribution to this knowledge.

It is a decrease in the absorption of radio waves by the lower ionosphere, after sunset, which makes it possible for your radio to receive the reflected signals of many distant radio stations which you cannot receive during the day.

In the second category of scientific investigation, that of viewing the earth from above, significant findings have been made in weather research.

The star performers in the weather field have been the TIROS satellites, which, along with the Echo balloon, are probably the best known of our unmanned satellites. TIROS has provided thousands of photographs of the earth's cloud cover which have provided useful information not available from ground based meteorological stations which cover a relatively small percentage of the surface of the earth.

The broader coverage provided by TIROS has enabled meteorologists to discover and track hurricanes and typhoons before they were detected by ground stations. Hurricane Esther, for example, was spotted by TIROS three days before it was picked up by other means.

TIROS is also providing weather researchers with important facts regarding the mechanics of the transfer of the sun's energy to the earth; how much is absorbed, how much is reflected, and how the local weather is affected by the variations in the rate of absorption and reflection.

The area of sun-earth relationships promises to be one of the most exciting and fruitful areas of space research, and is one on which we have made the most progress to date. Preliminary results hint at the interrelation that exists between the sun and what goes on in the earth's upper atmosphere, and scientists speculate that this effect eventually influences variations in our weather.

One objective of our scientific investigations is a more detailed, quantitative understanding of the physical phenomena involved. It has been predicted that some day in the future the understanding of this sun-earth interrelationship will have a direct impact upon our daily lives.

We have also observed, from studying the orbit of the Echo balloon, the changes in the orbit caused by solar radiation pressure and by atmospheric density variations induced by solar flares.

Studies of Vanguard I, still in orbit after more than four years, have also enabled the solar physicist to deduce something about radiation pressure from the sun; the upper atmosphere physicist to derive the temperatures and composition of the atmosphere at extreme altitudes and the influence of the sun on these characteristics; and the geologist to make deductions about the earth's crust.

Geodetic work in our space research has been equally interesting. School children were long taught that Columbus proved, in 1492, that the world is round. Scientists have considered it an oblate spheroid. It remained for the geodetic measurements taken in Project Vanguard to indicate that Columbus was wrong, and that the earth is really slightly pear-shaped.

The third category of scientific investigation in space, that of studying the sun, planets, and stars from beyond the earth's atmosphere, has challenged many previously existing theories.

Data from such spacecraft as Pioneer V, Explorer X, and Explorer XII have produced information regarding solar flares which, while far from conclusive, is of great interest to those who are planning future manned space flight missions. The measurements taken are being used to design the protection which a man will need from exposure to energetic particles -- electrons, protons, and neutrons -- while traveling in space.

Our scientists believe that, at least for a trip to the moon, a man can be adequately protected from all but the most extreme events. One objective of our solar studies is to devise a way of predicting when a major event, or solar flare, will occur. If we succeed in this, manned space shots will be timed to avoid these events, as an aircraft would avoid a severe thunderstorm which turned up on its radar.

One of our satellites has produced information that casts doubt on some aspects of one of the major theories of the origin of the universe. This version of the theory, called the steady state theory, includes an assumption that matter and anti-matter are being created continuously in space at a slow rate.

If this aspect of the theory were correct, the physicists tell us that there would have to be a sort of static condition of gamma rays throughout space. The Explorer XI satellite, launched by NASA last year, carried instruments to detect gamma rays, and test this theory. But in nine hours of observation, the Explorer XI observed gamma ray messengers at a rate far below what would be expected if the steady state theory were correct; information which poses another new challenge for the scientists.

Observations from high altitude rockets of ultraviolet radiations from various stars have upset a previously existing theory and indicate that the rate of energy release from hot young stars is much lower than had been supposed. This rate of energy release is an indicator of the process of development of a star, and our experimental results seem to imply that our present theories of stellar evolution, or the life cycle of stars, is incorrect.

Dr. Harry Goett, Director of NASA's Goddard Space Flight Center, commented recently that this information had, in a sense, sent the astrophysicists back to their drawing boards, reminding him of a pertinent quotation:

"The terrible tragedy of science is the horrible murder of beautiful theories by ugly facts."

The satellite with which we have studied the sun is the Orbiting Solar Observatory, which was launched from Cape Canaveral last March 7, and during eleven weeks of nearly perfect operation transmitted almost 1,000 hours of scientific information on solar phenomena.

OSO observed and measured more than 75 solar flares and sub-flares, mapped the sky in gamma radiation, examined energetic particles in the lower Van Allen Region, monitored the sun in a broad region of X-ray and gamma radiation, and performed surface-erosion studies of various kinds of materials.

Before a malfunction occurred in the spin-control system of this satellite on May 22, OSO had transmitted useful information through 1,138 orbits. Its highly advanced sun-sensing instruments kept instruments pointed toward the sun through each of these orbits, even though they lost contact with the sun every time the satellite passed behind the earth. The degree of accuracy involved was equivalent to scoring unerring bull's-eyes with a rifle aimed at a 2-1/2 foot balloon at a distance of one mile.

The benefits to basic science of our space program are only part of the story. The problems involved in launching vehicles and spacecraft beyond the earth's atmosphere are daily challenging the ingenuity of the Nation's scientists. Countless problems, associated with low temperatures, weightlessness, operation in a hard vacuum, extreme heat, weight and space limitations in spacecraft, are forcing scientists and engineers to search for new methods, new materials, new processes, new techniques of miniaturization.

The value of these discoveries is not limited to space research and technology. Many of them have practical applications in our daily lives, and are already having their effect on the way we live. It is from discoveries in this area that we may look forward to the establishment of many new industries, and of new products for manufacture by industries which already exist.

The scientific research and development required to achieve our national objectives in space will require the talents of young scientists and engineers in ever increasing numbers.

Despite the vast numbers who have been trained in recent years -- and it is estimated that about nine-tenths of all the men and women who ever received formal training in science and engineering are still alive today -- many more will be needed. Our space program needs physicists and chemists; electrical, structural, and mechanical engineers; mathematicians and statisticians; geologists and astronomers; biologists and those in many other scientific, engineering, and professional disciplines to deal with the new problems of the space environment.

The quantity and quality of the students educated by our elementary, secondary, undergraduate, and graduate schools now will determine, in large measure in future years, the excellence of our space program. I do not mean to imply that our schools, colleges, and universities should produce "space scientists" and "space engineers." It would be folly to concentrate on so-called "space science" at the expense of weakening our basic educational efforts in both the physical and social sciences.

Fortunately, this is not happening. It has been correctly said that space science is only science performed in space. The acceleration of research and development in the space field has heightened appreciation of the importance of research in other fields, as well, with an accompanying increase in expenditures for those purposes. Our space program, thus, is not being carried on at the expense of progress in other research fields, but actually has served as a stimulus for them. This is as it should be, for the program of space exploration must be an integral part of a balanced national effort in all fields of human knowledge. Our free society is dependent upon the successful integration of the new physical sciences and technologies into our political, economic, social, and educational, as well as national security systems.

While most students entering secondary schools and colleges are not thinking of careers in science and engineering, all students should acquire the understanding, appreciation, and knowledge which will enable them to cope with the rapid changes of this technological age. Students not majoring in science obviously do not require the highly specialized knowledge required by professionals. They should, however, be sufficiently familiar with science, mathematics, and engineering to comprehend the increasingly technological environment in which we live.

Similarly, just as the non-scientist student should have a basic understanding of science and technology as they affect society, so should the science or engineering major be afforded the opportunity to develop an appreciation of the social sciences, arts, and humanities. Narrow concentration of study within any field of knowledge, tends to beget a student and a person without the understanding required for a full and responsible life.

It is in this respect, perhaps, except for its vastly greater emphasis upon scientific and technical education, that the Soviet educational system differs in greatest degree from our own.

There is little in the educational system of the Soviet Union that corresponds to the American university liberal arts program. The extent of the orientation of Soviet higher education toward science and technology is measured by the fact that about 57 percent of all 1959 graduates at the bachelor degree level were in engineering, sciences, and selected applied science fields, compared with 24 percent in the United States. The professional instruction provided these graduates, although extensive in fundamentals of science and engineering, was found to be directed toward narrowly defined specialities with the main purpose of equipping the individual student to perform a specific job.

Yet, we should not minimize the fact that, with only half as many higher education graduates as the United States, the Soviet Union has a greater number of professionals in scientific, engineering, and other applied science fields, and the Soviet rate of growth in these fields is more than twice that of the United States.

While we produce about 90,000 engineering, science, and applied science graduates each year, the Soviet Union's production is currently 190,000. Projections indicate that during this decade the Soviet rate will reach 250,000 a year, more than twice the anticipated rate for the United States.

In advanced graduate education, the National Science Foundation reports that the Soviet production of candidate degree holders, roughly equivalent to the American Ph.D., is about the same, 8,500 per annum, as in the United States. But 75 percent of the degrees were awarded in the sciences and engineering, compared with 55 percent in our country.

Our colleges and universities, whether or not they offer it themselves, must continue to place more emphasis upon advanced study by college graduates, and particularly upon graduate education in science and technology. To you, who are graduating today, graduate study offers a field of very large opportunity for important service and a full and rich life.

I would hope also that our colleges and universities, in increasing degree, would associate research activities and graduate education wherever possible. This creates problems, of course, for some great teachers are equally eminent research people, but other notable scientists have little to do with teaching.

Universities which receive grants or contracts from government and industry often assign research projects to eminent and capable scientists who occupy themselves fully with achieving desired technical objectives, leaving little or no time for teaching. Yet it must be said that in the long run it is dangerous to separate research in any field of knowledge entirely from education. Obviously, the objective should be the attainment of a truly scholarly environment of inquiry, learning, and teaching.

Nor does it take an M. I. T. or a California Institute of Technology to contribute toward such a goal. A college such as Wilkes, for example, has a great opportunity to contribute to the advancement of science, even though this contribution involves only the contribution of a single man or group, working on a single specific problem.

An ancient Chinese philosopher, expressing his hopes for the young people of his generation, stated them with profound simplicity. He said:

"May you live in interesting times."

Certainly this is one of the assets which is yours as you leave Wilkes College to face the uncertainties, the realities, and the opportunities of life in our contemporary society. You do live in interesting times.

But more than this -- and unlike most of the descendants of that Chinese philosopher -- you have the advantages of participating in these interesting times as Americans -- a privilege which you must not underestimate or overlook.

What being an American means in an age such as this was expressed with great clarity by President Kennedy in 1960, when he wrote:

"The American, by nature, is optimistic. He is experimental, an inventor, and a builder who builds his best when called upon to build greatly. Arouse his will to believe in himself, give him a great goal to believe in, and he will create the means to reach it. This trait of American character is our greatest national asset."

On this graduation day you <u>have</u> a great goal to believe in.

May you also have the will to believe in yourselves, and the imagination and the initiative to benefit from and contribute to the age of science and technology in which we live.

Congratulations and good luck.

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